ADVANCED QUANTIFICATION OF THE NEONATAL HEART-RATE VARIABILITY BY SPECTRAL ANALYSIS

J. Gadzinowski, A. Lindqvist, H. Anttila, R. Oja, K. Antila and I. Välimäki

Cardiorespiratory Research Unit, University of Turku, Finland, Neonatal Department, Institute of Obstetrics and Gynaecology, Medical Academy of Poznan, Poland, and Department of Paediatrics, University of Turku, Finland.

Monitoring of heart-rate variability (HRV) has been clinically used in cardiotochography and in neonatal intensive care. For clinical purposes visual analysis of the instantaneous heart-rate (IHR) curve is often sufficient. However, for quantitative investigation of cardiac control mechanisms more advanced techniques are necessary. For experimental studies in lambs and clinical neonatal monitoring we have developed the following methods:

A bipolar electrocardiogram lead was recorded under visual control using a neonatal monitor (Corometrics 512) on analogue magnetic tape by FM tape recorder (Racal 4 ds). The record was played back at 8 times real-time speed. The R-R intervals were digitized by an interval counter with an accuracy of 1 msec. The signal analysis was performed by digital computer (Nova 3 and Eclipse C/150, Data General Corporation, Southboro, Mass., USA). The R-R interval signal was equispaced by using sin (x)/x digital lowpass filtering. The cut-off frequency (F_c) was determined on the basis of the longest R-R interval in the original recording. The sampling frequency equaled 2.2 * F_c.

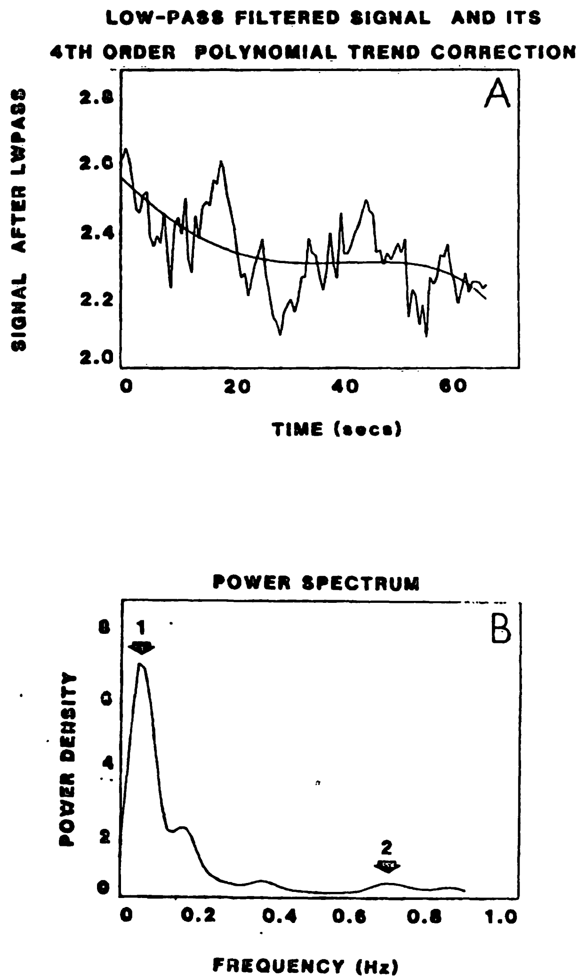

Fig. 1A. Trend corrected heart rate signal
1B. Power spectrum of the case in Fig. 1 A

Polynomial trend correction was used to remove the undesirable slow trends in the resulting time series. The degree of the polynomial was selected in the way that the periodicity of interest in the signal was not removed (Fig. 1A). The oscillatory HRV components, often superimposed in the heart-rate, were quantified by computing the power spectrum of the lowpass filtered time series. An FFT program was used. Relative distribution of the power of the HRV can be seen in Fig. 1B. Finally, for investigation of the periodic oscillatory HRV in a group of records or patients a method of multiple band integration of the power spectral density was developed. The relevant spectral densities were integrated over frequency. These values representing accumulation of the HRV at the frequency bands of interest were used to combine the information of the power spectra of several records or patients (Fig.2). In this fashion, components of the HRV on the low frequency band related to vasomotor control (arrow 1, Fig 1B) and on the higher frequency band related to respiratory activity (arrow 2, Fig. 1B) have been quantitatively featured in newborn infants.

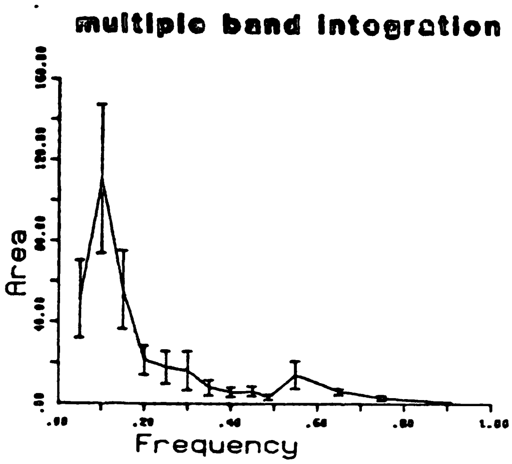

Fig. 2. Multiple band integration of the power spectral density in 10 newborn infants

Reference: Lindqvist, A., Oja, R., Hellman, O. and Välimäki, I.: Impact of thermal vasomotor control on the heart rate variability of newborn infants. Early Hum. Develop. 8, 37-47, 1983.

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